

## APPENDIX 1 VEHICLE AND TEST INFORMATION

|   |   |
|---|---|
| <b>Test No.:</b>                              | 1250  |
| <b>Contract or Study Title:</b>               | SIDE IMPACT PROTECTION IN PRODUCTION VEHICLES |
| <b>Test Performer:</b>                        | TRANSPORT CANADA                              |
| <b>Test Reference No.:</b>                    | 88-017  |
| <b>Test Type:</b>                             | BASELINE TEST                                 |
| <b>Test Configuration:</b>                    | IMPACTOR INTO VEHICLE                         |
| <b>Closing Speed (kph):</b>                   | 50.2  |
| <b>Impact Angle (degrees):</b>                | 270   |
| <b>Offset Distance (mm):</b>                  | 0   |
| <b>Version No.:</b>                           | 1   |
| <b>Test Objectives:</b>                       | SIDE IMPACT RESEARCH                          |
| <b>Test Date:</b>                             | 15-SEP-88                                     |
| <b>Contract No.:</b>                          |   |
| <b>Test Track Surface:</b>                    | CONCRETE                                      |
| <b>Test Track Condition:</b>                  | DRY   |
| <b>Ambient Temperature (degrees Celsius):</b> | 13.887  |
| <b>Type of Recorder:</b>                      | FM MULTIPLEXOR TAPE RECORDER                  |
| <b>Side Impact Point (in mm):</b>             | -514.401                                      |
| <b>Total No. of Curves:</b>                   | 40  |
| <b>Test Commentary:</b>                       | NO COMMENTS                                   |
| <b>VEHICLE INFORMATION:</b>                   |   |
| <b>Vehicle No.:</b>                           | 2   |
| <b>Vehicle Make:</b>                          | FORD  |
| <b>Vehicle Model:</b>                         | TAURUS  |
| <b>Model Year:</b>                            | 1988  |
| <b>Engine Type:</b>                           | V6 INLINE FRONT                               |
| <b>Engine Displacement (liters):</b>          | 3   |
| <b>Vehicle Test Weight (Kgrams):</b>          | 1642.005                                      |
| <b>Vehicle Length (mm):</b>                   | 4791.634                                      |
| <b>Vehicle Width (mm):</b>                    | 1809.369                                      |
| <b>Body Type:</b>                             | FOUR DOOR SEDAN                               |
| <b>Vehicle Identification No.:</b>            | 1FABP5OUXJG128782                             |
| <b>Transmission Type:</b>                     | AUTOMATIC - FRONT WHEEL DRIVE                 |

## APPENDIX 2

### BROAD APPROXIMATIONS TO INJURY STATISTICS

Exact correlations to injury statistics are not possible for the new architecture. However, this section attempts to provide an indication of possible benefits in the new system in terms of the incidence of AIS 3+ injuries.

Rouhana and Foster (13) provides data on injuries from Car-Car side impact from NCSS accident data which is reproduced below. This analysis differs from that of Viano (14), of the same data in that we have a totally different architecture and do not perform analysis relative to thoracic viscous compression. Our analysis assumes that the injury is produced by the peak acceleration of the thorax.

Calibrating the table provided by Rouhana and Foster to the measured peak thoracic acceleration of 67Gs or 656 M/s/s in the test considered in this paper assuming linearity in the correlation and setting the Mean delta V to about 60% of 50.3 km/h or 8.38 m/s, gives an AIS 3+ percentage of about 9.0 % from the table1. The Millennium System peak thoracic acceleration is 29 Gs or 284 m/s/s which corresponds to 43% of the peak acceleration of the conventional architecture that should correspond with 43% of the "equivalent" mean delta V in terms of injury impact for this architecture or 3.6m/s which results in a AIS 3+ of about 2 % . **This represents a 77% drop in AIS3 + injuries.**

Table 1

| Mean Delta V | Possible injury exposure |       | Injuries AIS 3+ |       |
|--------------|--------------------------|-------|-----------------|-------|
|              | Number                   | %     | Number          | %     |
| M/s          |                          |       |                 |       |
| 1.35         | 98                       | 1.62  | 3               | 3.06  |
| 2.7          | 680                      | 11.24 | 10              | 1.47  |
| 4.05         | 1222                     | 20.2  | 28              | 2.29  |
| 5.4          | 1283                     | 21.2  | 70              | 5.46  |
| 6.75         | 1049                     | 17.34 | 62              | 5.91  |
| 8.1          | 866                      | 14.31 | 77              | 8.89  |
| 9.45         | 341                      | 5.64  | 33              | 9.68  |
| 10.8         | 142                      | 2.35  | 11              | 7.75  |
| 12.15        | 151                      | 2.5   | 24              | 15.89 |
| 13.56        | 86                       | 1.42  | 36              | 41.86 |
| 14.85        | 62                       | 1.02  | 22              | 35.48 |
| 16.2         | 33                       | .55   | 5               | 15.15 |
| 17.55        | 21                       | .35   | 3               | 14.29 |
| 18.9         | 17                       | .28   | 12              | 70.59 |
| 20.25        | 0                        | 0     | 0               | 0     |

## REFERENCES

1. National Highway Traffic Safety Administration, Traffic Safety Facts, 1997.
2. National Highway Traffic Safety Administration, Fatal Accident Reporting System, 1980.
3. National Highway Traffic Safety Administration, Federal Motor Vehicle Safety Standard 214, Code of Federal Regulations Title 49, Part 571.214. The Code is published annually by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC, with NHTSA standards in the volume "Title 49, Parts 400 - 999."
4. Byron Block Advanced Designs for Side Impact Protection, 16th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Volume 3, pages 1778 - 792, NHTSA Technical Report DOT HS 808 759, October, 1998 This is available from the National Technical Information Service, Arlington, Virginia.
5. Hansun Chan, James R. Hackney, Richard M. Morgan, and Heather E. Smith, An Analysis of NCAP Side Impact Crash Data, Volume 3, pages 2490 - 2502, 16th ESV, NHTSA Technical Report DOT HS 808 759, October, 1998.
6. Carl C. Clark, Human Transportation Fatalities and Protection Against Rear and Side Crash Loads by the Irstop Restraint, Proceedings of the 6th Stapp Car Crash Conference, 1965, University of Minnesota Press, 1996.
7. Charles F. Warner (Collision Safety Engineering, Orem, Utah), Inflatable Structures for Enhanced Side Impact Crash Protection, Final Report of the Small Business Innovative Research contract #DTRS-57-87-C-00089, April, 1988.
8. Carl C. Clark and William A. Young, Airbag Bumpers Inflated Just Before the Crash, Society of automotive Engineers Technical Paper SAE 841051, March, 1994.
9. Carl C. Clark and William A. Young, Car Crash Theory and Tests of Airbag Bumper Systems, SAE 951056, March, 1995.
10. Rajasingham, A.I. Unpublished research 1993-2000 prior to pending patents.
11. Robert L. Carter, Passive Protection at 50 Miles Per Hour, NHTSA Technical Report DOT HS 810 197, June, 1972.
12. Claes Tingvall, Anders Lie, "the indications of the zero vision on biomechanics Research". International IRCOBI Conference on the Biomechanics of Injury, December 1996.
13. Rauhana, SW and Foster, M.E., "Lateral impact - An analysis of the statistics in the NCSS" SAE 851727, 1985.
14. Viano David. C. "Evaluation of the benefits of Energy Absorbing Materials in Side impact Protection: Part-1". SAE 872212. 1987.
15. Articulated Total Body (ATB). US Airforce. Wight Patterson Airforce Base. 1999.

TOP SECRET - 44-38861-250

ILLUSTRATION-1.



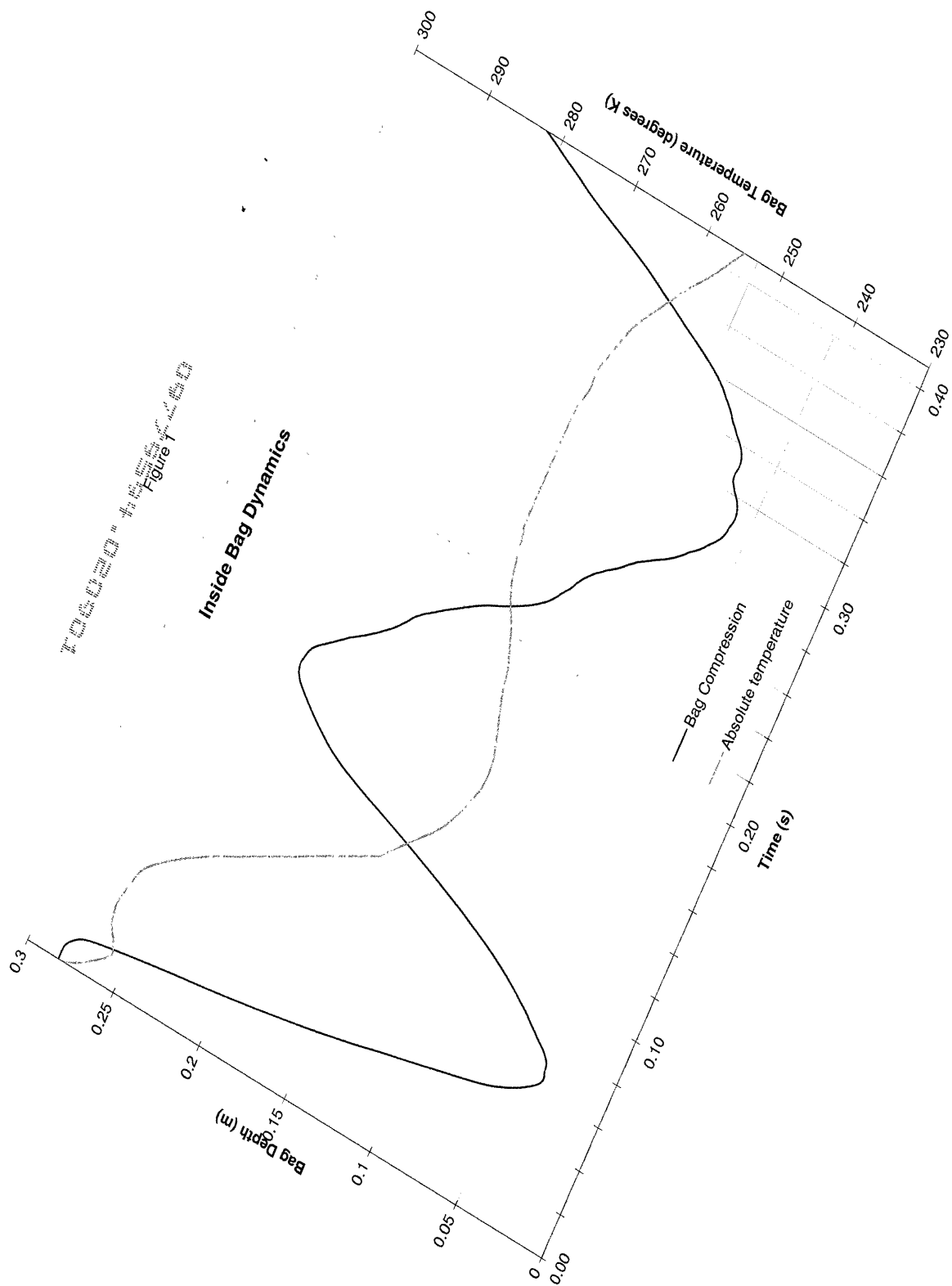


Figure 1-10

Figure 2

# Acceleration External Airbag failure (worst case)

- Door - Unfiltered
- Door - Filtered
- Actual Pelvis
- Millennium

Acc (Gs)

Time (s)

200

150

100

50

0

-50

0.00

0.05

0.10

0.15

0.20

0.25

0.30

0.35

0.40

Figure 3

Velocity Impacting surface & Human carriage

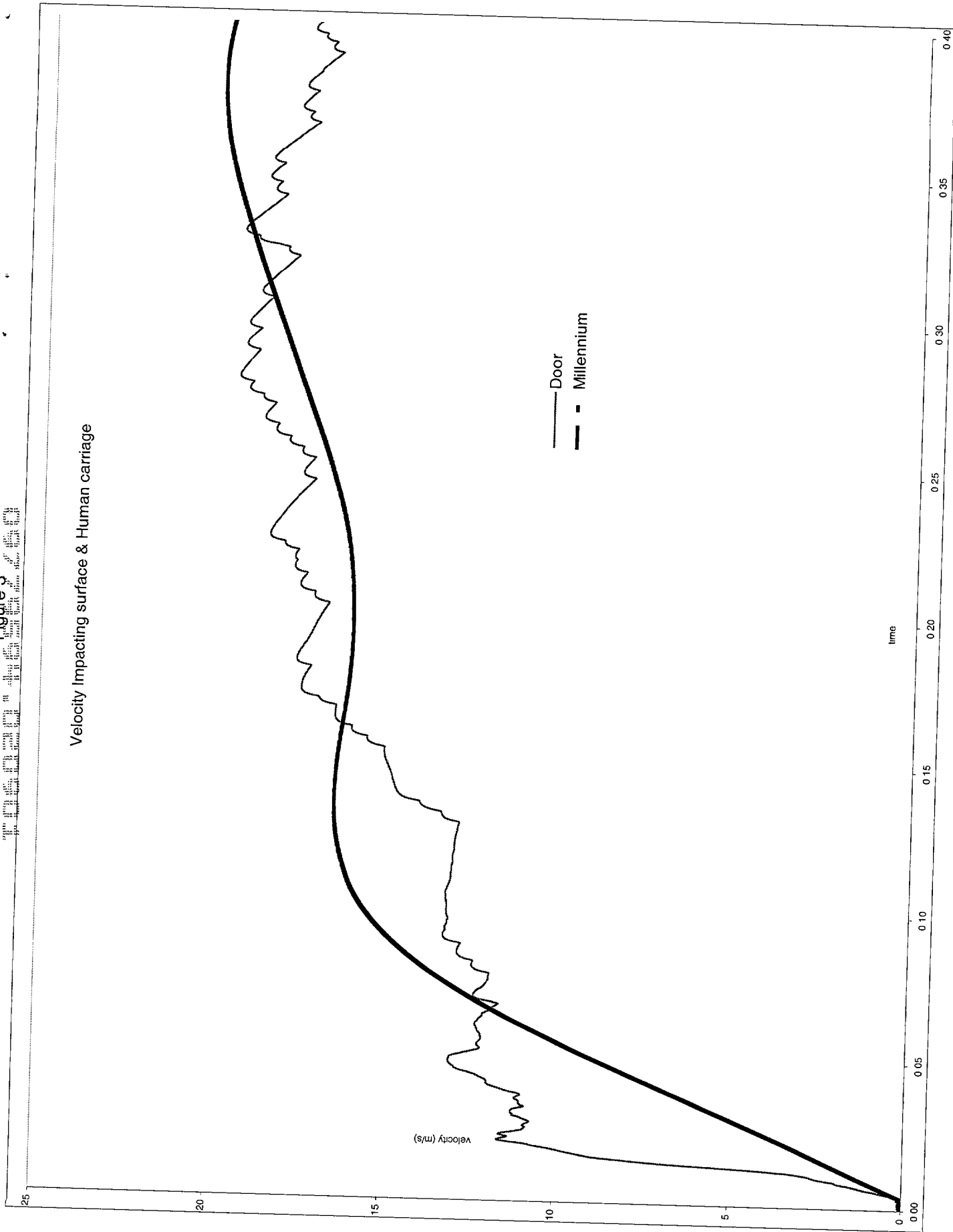
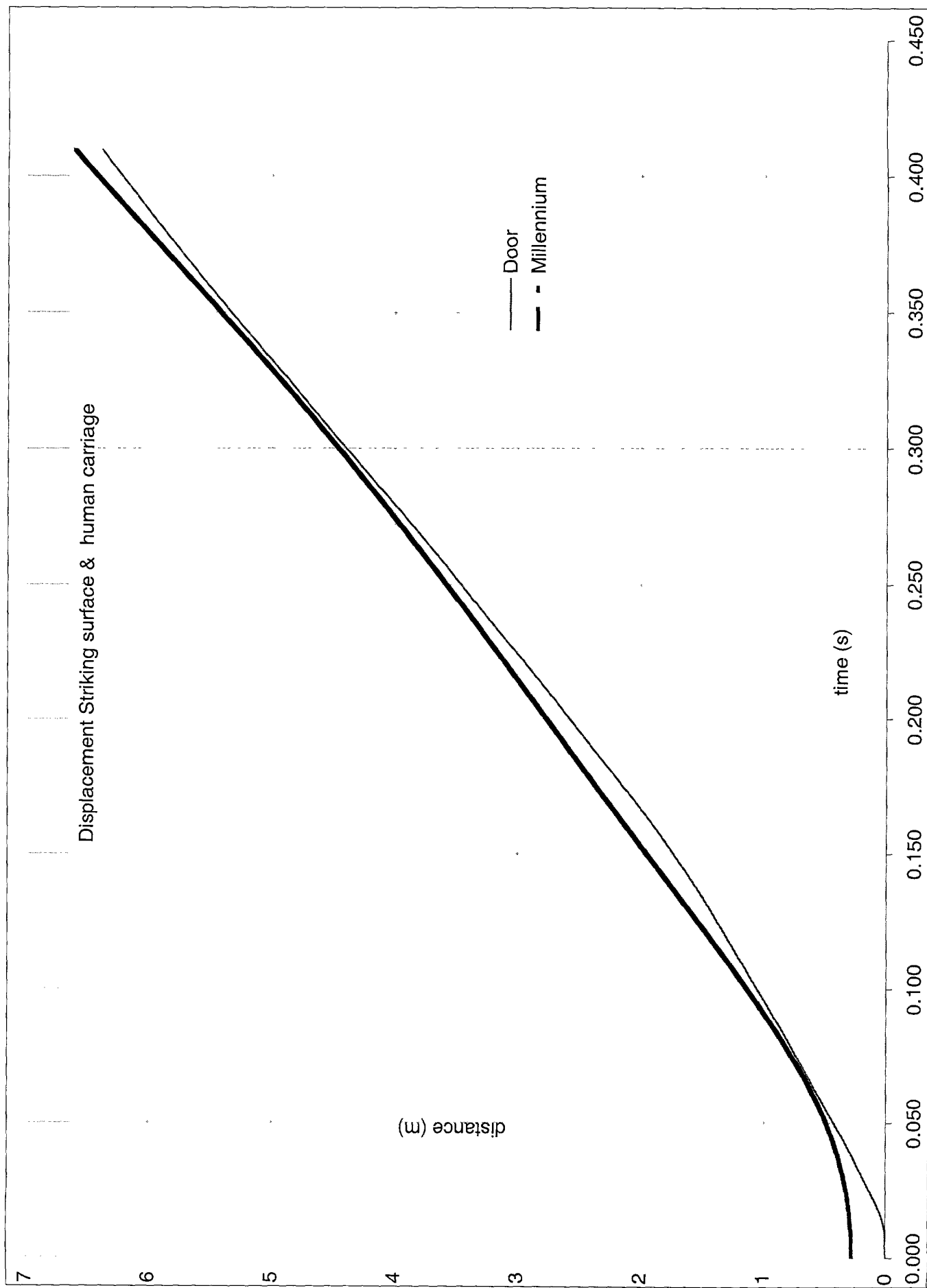
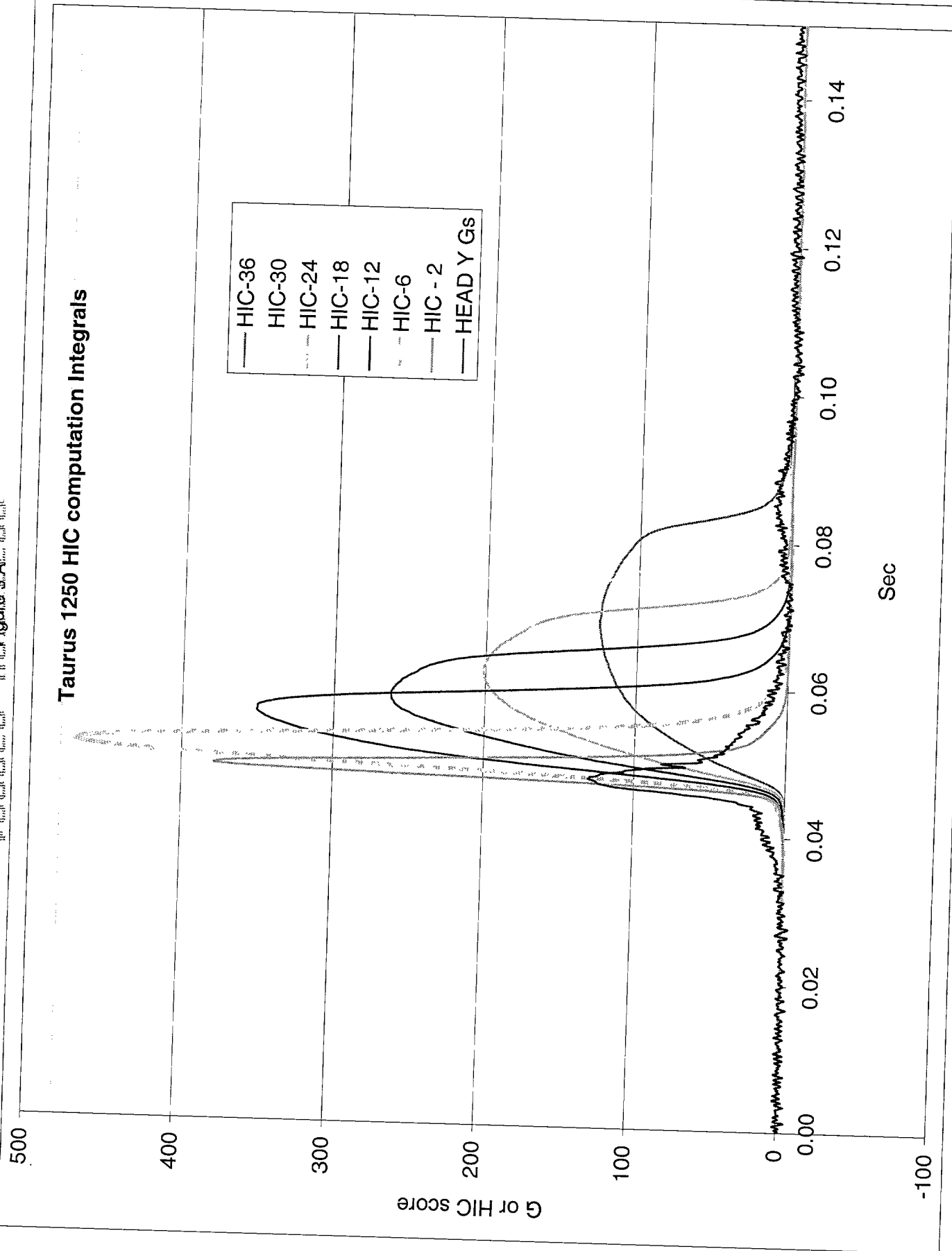


Figure 4.2.6a

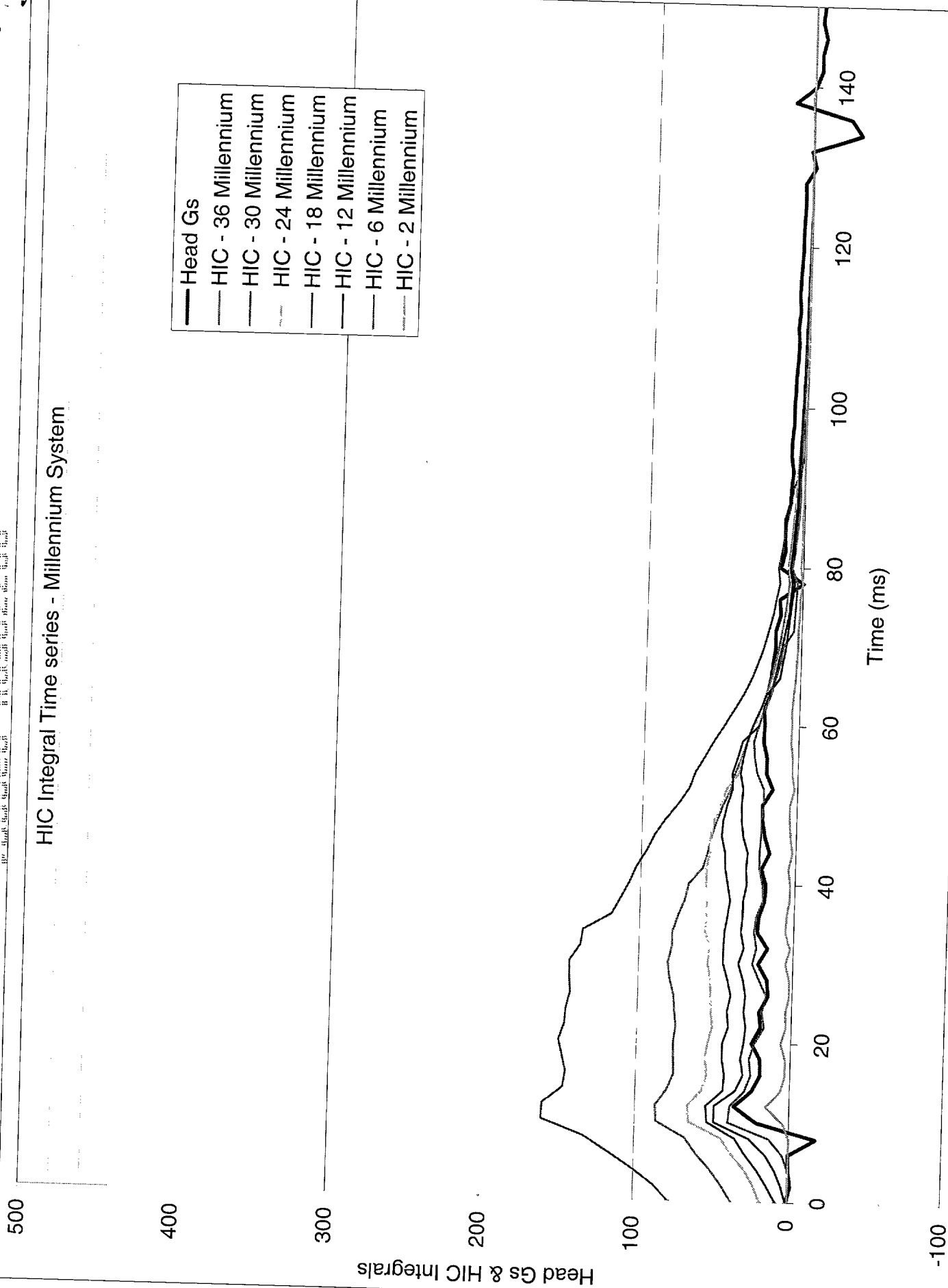


## Taurus 1250 HIC computation Integrals



HIC Integral Time series - Millennium System

- Head Gs
- HIC - 36 Millennium
- HIC - 30 Millennium
- HIC - 24 Millennium
- HIC - 18 Millennium
- HIC - 12 Millennium
- HIC - 6 Millennium
- HIC - 2 Millennium



Chest Acceleration - Standard architecture

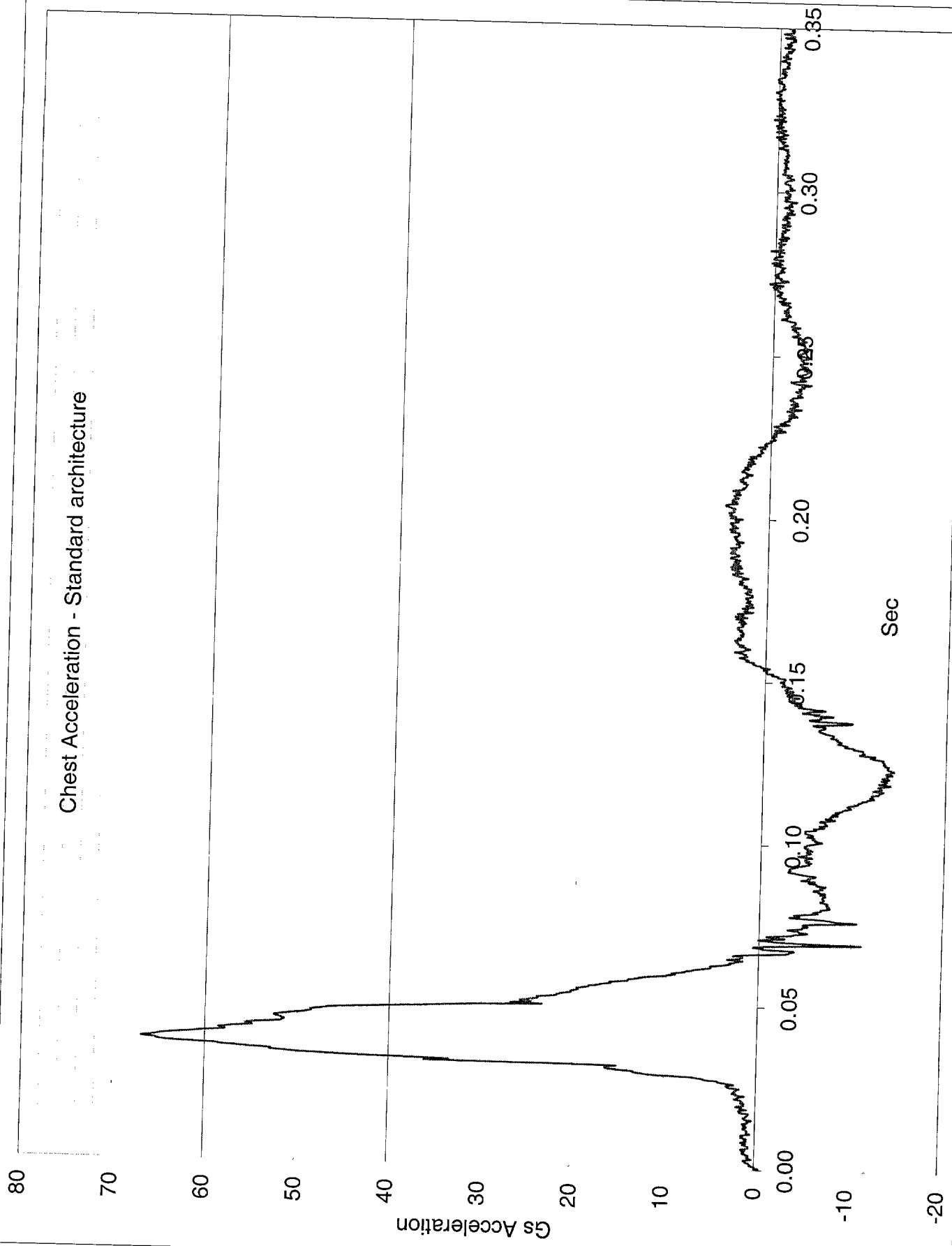


FIG 6-A

